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Enclosed herewith for filing is a patent application, as follows:

Inventor(s): Konetski, David; Curley, Joe
Client: Dell USA, L.P.
Title: Integrated Self Diagnostics For Loudspeaker Systems

X Return Receipt Postcard
X This Transmittal Letter (in duplicate)
3 page(s) Declaration For Patent Application and Power of Attorney
12 page(s) Specification
4 page(s) Claims
1 page Abstract
4 Sheet(s) of Drawings
1 page(s) Recordation Form Cover Sheet (in duplicate)
1 page(s) Assignment
1 page(s) Information Disclosure Statement
1 page(s) PTO Form 1449 with copies of 3 cited references

CLAIMS AS FILED (fees computed under §1.9(f))

For	Number Filed			Number Extra		Rate		$	Basic Fee 760.00
Total Claims	23	-20	=	3	x	$18	=	$	54.00
Independent Claims	2	-3	=	0	x	$78	=	$	0.00
☐ Application contains one or more multiple dependent claims ($260 total fee)								$	0.00

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Respectfully submitted,

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INTEGRATED SELF DIAGNOSTICS FOR LOUDSPEAKER SYSTEMS

David Konetski
Joe Curley

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to audio speakers, and more particularly to a system for performing self-diagnostics on audio speaker systems.

Description of the Related Art

Computer systems in general and personal computer systems in particular have attained widespread use for providing computer power to many segments of today's modern society. A personal computer system can usually be defined as a desktop, floor standing, or portable microcomputer that includes a system unit having a system processor and associated volatile and non-volatile memory, a display monitor, a keyboard, one or more diskette drives, a fixed disk storage device and an optional printer. One of the distinguishing characteristics of these systems is the use of a system board to electrically connect these components together. These personal computer systems are information handling systems which are designed primarily to give independent computing power to a single user (or a relatively small group of users in the case of personal computers which serve as computer server systems) and are inexpensively priced for purchase by individuals or small businesses. A personal computer system may also include one or a plurality of I/O devices (i.e. peripheral devices) which are coupled to the system processor and which perform specialized functions. Examples of I/O devices include modems, sound and video devices or specialized communication devices. Mass storage devices such as hard disks, CD-ROM drives and magneto-optical drives are also considered to be peripheral devices.

Computers producing multimedia effects (e.g., sound coupled with visual images) are in increased demand as computers are used for artistic endeavors, for entertainment, and for education. The use of sound makes game playing more realistic and helps reinforce knowledge and make educational programs more enjoyable to use. Digital effects and music can also be created on the computer and played through attached speakers without the need for additional musical instruments or components.

Multimedia systems today often include audio devices (e.g., sound cards) connected to the computer to which speaker systems can be attached for playing music and other sound effects. The speaker systems include analog circuitry, such as, for example, volume controllers, tone processors, equalizers, and attenuators. Even speaker systems with high digital computing content nonetheless include a large component of analog circuitry.

Testing and diagnosis of these analog portions of a speaker system pose challenges to modern computer manufacturing and repair facilities, and to field diagnostics personnel. In prior art speaker systems, if the system fails to operate in an application, the operator can only manipulate the inputs to the speaker (i.e., signal, power, and controls) in order to determine whether the speaker system is functioning correctly. It is known in the art to test the operability of analog components of the speaker system by invoking a test procedure that plays music or a test pattern on the speakers. An operator, usually a user or technician, listens to the resulting output of the speakers to determine whether the test passes or fails.

A challenge of testing and diagnosing speaker systems by listening to the result in a manufacturing or test facility arises because the test area is often noisy, which renders it difficult to distinguish one system being tested from another. In addition, to thoroughly test a speaker system, the operator must listen to a variety of sounds to ensure that the system is working properly. This approach is time-consuming and can adversely affect the throughput of the manufacturing facility. Finally, human error, which may be caused by repetitively listening to numerous systems, may cause the technician to pass an audio device which would otherwise fail.

Similarly, human error is also a challenge for field diagnostics personnel, such as tech support providers. In such situations, a user may not fully understand the installation and testing procedures for a speaker subsystem, and therefore may impart erroneous information to the tech support provider.

An improvement to the testing and diagnosis of audio speaker systems is needed which alleviates the burden on users or technicians who manually listen to sounds. What is desired is a manner of, in addition to listening to sounds, obtaining reliable, easy-to-interpret results from the testing of the internal circuitry of the speaker system.

SUMMARY OF THE INVENTION

The present invention relates to a self-diagnostic circuit for speaker systems that allows a speaker system to generate its own test signals, e.g., tones, appropriate for the transducer(s) in the speaker system. The test signals are routed to the analog circuits in the speaker system. The test signals are also routed to the transducers, so that an operator can evaluate speaker output tones. In one embodiment, the test signals are also routed to an analog activity sensor that senses activity in the speaker analog circuit paths and sends a status indicator to be displayed to the operator. In a first embodiment, the self-diagnostic circuit is part of a stand-alone speaker system, such as a home theater sound system. In a second embodiment, the self-diagnostic circuit is included in a speaker system that is included in a computer system.

In both the stand-alone and computer system embodiments, the speaker system includes at least one transducer, at least one speaker analog circuit, and a diagnostics circuit coupled to them both. The diagnostics circuit includes a power diagnostics circuit and an analog diagnostics circuit. In this manner, the integrated diagnostics of the speaker system tests both the analog circuits and the power circuit.

Regarding the power diagnostics circuit, one embodiment includes at least one AC power test indicator that indicates whether the speaker system is receiving AC power from the rectifier in the power circuit. The AC power test indicator is coupled

to the rectifier. In a second embodiment, the power diagnostics circuit includes at least one DC power test indicator that indicates whether the speaker system is receiving DC power from the AC-to-DC conversion circuit in the power circuit. The DC power test indicator is coupled to the AC-to-DC conversion circuit. An alternative embodiment may include both the AC and DC power test indicators.

Regarding analog diagnostics, the analog diagnostics circuit includes a diagnostic mode activation mechanism, such as a switch or button. The activation mechanism is coupled to a diagnostic signal generation circuit, and indicates to the signal generation circuit that an operator is requesting that diagnostics be run. In response, the diagnostic signal generation circuit generates at least one test signal. Each test signal is routed to one or more of the speaker analog circuits, and to at least one transducer. The diagnostic signal generation circuit is therefore coupled to at least one of the speaker analog circuits and to at least one transducer. Each speaker analog circuit receives at least one test signal, as does each transducer. In this basic embodiment, an operator gets an overall indication of system operability by noting whether or not the sound of the test signal emanates from the transducers.

In a second embodiment of the analog diagnostics circuit, the operator gets a more specific indication of speaker system functionality. In this second embodiment, an analog activity sensor samples the output of each speaker analog circuit to determine whether the test tones are being passed through the analog circuit. In one embodiment, the analog activity sensor is made of at least one transistor; in a second embodiment it is made of at least one comparator. In the preferred embodiment, the test signals are sampled by the analog activity sensor both before *and* after being routed to each speaker analog circuit in their test path. In an alternative embodiment, the test signals are routed to the analog activity sensor only *after* being routed to each speaker analog circuit in their test path. The analog activity sensor generates a status indicator for each speaker analog circuit sampled. Each status indicator is routed to an analog test indicator (which is coupled to the analog activity sensor) so that the operator gets a visual indication of functionality for each speaker analog circuit. In an

alternative embodiment, a less specific description of system operability may be obtained by routing more than one status indicator to a single analog test indicator.

The computer system embodiment of the present invention includes the speaker system described above, as well as a processor and memory, where the speaker system and memory are both coupled to the processor.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention may be better understood, and its numerous objects, features, and advantages made apparent to those skilled in the art, by referencing the accompanying drawings.

FIGURE 1 is a block diagram of a computer system that includes a speaker system.

FIGURE 2 is a block diagram of an exemplary speaker system embodying the integrated diagnostics of the present invention.

FIGURE 3 is a block diagram of a circuit that performs analog diagnostics within an audio speaker system.

FIGURE 4 is a block diagram of a circuit that performs power diagnostics within an audio speaker system.

The use of the same reference symbols in different drawings indicates similar or identical items.

DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

The following sets forth a detailed description of a mode for carrying out the invention. The description is intended to be illustrative of the invention and should not be taken to be limiting.

FIGURE 1 is a block diagram of an exemplary computer system **100** that includes a speaker system **145**. The computer system **100** may be found in many

forms including, for example, mainframes, minicomputers, workstations, servers, personal computers, internet terminals, notebooks and embedded systems. Personal computer (PC) systems, such as those compatible with the x86 configuration, include desktop, floor standing, or portable versions. A typical PC computer system **100** is a microcomputer that includes a microprocessor (or simply "processor") **110**, associated memory **150** and control logic and a number of peripheral devices **130, 187, 191, 145** that provide input and output for the system **100**. A typical computer system **100** may also include a cache **115** to facilitate quicker access between the processor **110** and main memory **150**. The peripheral devices often include speaker systems **145**, keyboards **191**, graphics devices **130**, and traditional I/O devices **187** that often include display monitors, mouse-type input devices, floppy and hard disk drives, CD-ROM drives and printers. The number of devices being added to personal computer systems continues to grow. For example, many computer systems also include network capability, terminal devices, modems, televisions, sound devices, voice recognition devices, electronic pen devices, and mass storage devices such as tape drives, CD-R drives or DVDs. The peripheral devices usually communicate with the processor over one or more buses **120, 160, 180**, with the buses communicating with each other through the use of one or more bridges **140, 170**.

One skilled in the art will recognize that the foregoing components and devices are used as examples for sake of conceptual clarity and that various configuration modifications are common. For example, the audio controller **155** is connected to the PCI bus **160** in **FIGURE 1**, but may be connected to the ISA bus **180** or other appropriate I/O buses in alternative embodiments. As further example, processor **110** is used as an exemplar of any general processing unit, including but not limited to multiprocessor units; host bus **120** is used as an exemplar of any processing bus, including but not limited to multiprocessor buses; PCI bus **160** is used as an exemplar of any input-output devices attached to any I/O bus; AGP bus **102** is used as an exemplar of any graphics bus; graphics device **130** is used as an exemplar of any graphics controller; and host-to-PCI bridge **140** and PCI-to-ISA bridge **170** are used as exemplars of any type of bridge. Consequently, as used herein the specific

exemplars set forth in **FIGURE 1** are intended to be representative of their more general classes. In general, use of any specific exemplar herein is also intended to be representative of its class, and the non-inclusion of such specific devices in the foregoing list should not be taken as indicating that limitation is desired

FIGURE 2 shows an exemplary speaker system **145** embodying the present invention. The speaker system **145** includes at least one speaker that includes at least one transducer. **FIGURE 2** shows a speaker system including a left speaker **220** and a right speaker **240**. The speaker system may also include additional speakers, such as a center speaker **210** or rear speakers (not shown) present in many known home theater sound systems. The speaker system **145** may also include at least one subwoofer **230.** Each speaker **210, 220, 230, 240** includes at least one transducer **211, 221, 231, 241**, respectively, and may also include at least one amplifier (not shown).

The speaker system **145** also includes a control circuit **200** embodying the diagnostics circuit **295** of the present invention. While the control circuit **200** is depicted in **FIGURE 2** as a discrete element of the speaker system **145**, it may physically reside in the subwoofer **230** (if present) or in another speaker of the speaker system **145**. Alternatively, each speaker of the speaker system **145** could include a separate dedicated control circuit **200**. **FIGURE 2** shows that the control circuit **200** sends a rectified power signal **285** to at least one speaker and at least one diagnostic signal **280, 282** to each speaker **210, 220, 230, 240** in the speaker system **145.** The control circuit **200** also sends one or more status indicators **206** to each analog test indicator **260a-260n**. The analog test indicators **260a-260n** are discussed below in connection with **FIGURE 3**.

FIGURE 2 shows that the diagnostics circuit **295** includes two test circuits: power diagnostics **270** and analog diagnostics **275**. The power diagnostics **270** are further shown in **FIGURE 4** and are discussed below. Regarding the analog diagnostics **275**, **FIGURE 3** is a block diagram of the circuit **275**, that performs analog diagnostic testing within an audio speaker system **145.**

FIGURE 3 shows that the analog diagnostics **275** are invoked when the diagnostic mode activation mechanism **302** signals that the diagnostic mode has been selected by the operator. The physical implementation of the mechanism **302** may be any conventional implementation known in the art and varies according to design concerns and the physical characteristics of the speaker system **145.** For instance, the mechanism **302** may be implemented as an additional hardware switch or button. In other speaker systems, the indicator **302** may implemented using an existing mode button.

When the diagnostic mode activation mechanism **302** is activated, the diagnostic signal generation circuit **300** generates one or more test signal(s) **280**, **282**. The test signal(s) **280, 282** generated by the signal generation circuit **300** have a two-fold purpose: analog circuitry diagnosis as well as speaker transducer diagnosis. Regarding the latter, the test frequencies generated by the signal generation circuit **300** must be in the audible range so that the operator can determine whether sound is emanating from the transducer during the diagnostic session. The signal generation circuit **300** must therefore generate sufficient test signals **480, 482** to exercise all of the transducers in the speaker system **145** at the appropriate frequency. For example, if the speaker system **145** consists of only a stereo pair of full-range satellite speakers **220** and **240**, a single mid-range test frequency **280** injected into both speakers **220**, **240** will adequately diagnose the speaker system. If, however, the speaker system further consists of a subwoofer **230** such as that shown in **FIGURE 2**, a second signal frequency **482** is required to exercise the subwoofer **530**.

The physical implementation of the signal generation circuit **300** shown in **FIGURE 3** varies according to speaker system architectures. For instance, in a speaker system that incorporates a microprocessor, the preferred physical implementation of the signal generation circuit **300** uses the microprocessor to generate the test frequencies **280, 282** necessary for speaker system diagnosis. In contrast, in a pure analog architecture the signal generation circuit **300** is a separate hardware element. In such case, the preferred signal generation circuit **300** exhibits low cost and high

reliability. Two examples of such signal generation circuits are 1) low-cost crystal oscillator circuits, and 2) semiconductor timing circuits such as the 555 timer.

FIGURE 3 shows that the test signals **280**, **282** generated by the signal generation circuit **300** are routed to one or more speaker analog circuits **290a-290n** and to one or more transducers **221**, **211**, **241**, **231** of the speaker system. The test signals **280**, **282** are also routed to the analog activity sensor **304**. The analog activity sensor **304** must sample activity at all critical junctions in the speaker system circuit. Where these critical junctions lie depends on the architecture of the speaker subsystem.

Regarding the speaker analog circuits **290a-290n** shown in **FIGURE 3**, the present invention may be implemented in any configuration of speaker system. Various speaker designs include differing speaker analog circuits **290a-290n** because each has different stages of attenuation, power, equalization, etc. Typical examples of speaker analog circuits **290a-290n** include input attenuation, tone processing, master volume control, and equalization. Depending on the configuration of the speaker subsystem, a particular test signal **280, 282** may not be routed to every speaker analog circuit **290a-290n**. The speaker analog circuits **290a-290n** and transducer(s) through which a test signal is designed to flow is referred to as that test signal's test path.

FIGURE 3 shows that the test signals **280**, **282** are sampled before and after transmission to each speaker analog circuit **290a-290n** in their test path. This sampling is performed by routing the test signals **280a-280d** and **282a-282d** to the analog activity sensor **304**. **FIGURE 3** illustrates the preferred embodiment, where the test signals **280, 282** are sampled by the analog activity sensor **304** both before *and* after being routed to each speaker analog circuit **290a-290n** in their test path. In alternative embodiments, the test signals **280**, **282** are routed to the analog activity sensor **304** only *after* being routed to each speaker analog circuit **290a-290n** in their test path.

The analog activity sensor **304** shown in **FIGURE 3** receives the sampled signals **280a-280d**, **282a-282d** and generates a separate status indicator **206a-206n**

for each speaker analog circuit **290a-290n**, respectively. In an alternative embodiment, the analog activity sensor and status indicators **206a-206n** are not present. This latter embodiment capitalizes on the fact that the test signal **280, 282** must pass through each speaker analog circuit **290a-290n** in the test path before reaching the transducer. If one or more of the speaker analog circuits **290a-290n** is not operating, the test signal will not reach the transducer, and no sound will emanate from the transducer. This embodiment thus produces a large-scale indication of subsystem operability, which is particularly useful in speaker subsystems that contain a microprocessor to regulate controls. In contrast, the preferred embodiment uses the analog activity sensor **304** and status indicators **206a-206n** to generate a more detailed indication of operability for individual speaker analog circuits **290a-290n**. An intermediate indication of operability can be generated in an alternative embodiment by routing more than one status indicator **206a-206n** to a single analog test indicator **260a-260n (FIGURE 2).**

In the preferred embodiment, analog activity sensor **304** "senses" each sampled signal **480a-480d**, **482a-482d** with a separate transistor (not shown) that acts as a switch. As the active signal oscillates, the transistors switch DC voltage, each creating a Pulse Width Modulated (PWM) signal. The PWM signals are presented as inputs to the respective analog test indicator **260a-260n (FIGURE 2)** as its input, resulting in the analog test indicator **260a-260n** indicating when there is activity on the speaker analog circuit **290a-290n** under test. In an alternative embodiment, the function of the analog activity sensor **304** can also be accomplished with comparators providing the PWM input into the analog test indicator **260a-260n**. In either embodiment, the preferred analog test indicator **260a-260n** includes an LED circuit or LED array circuit. With the alternative comparator architecture, the LED drive must be generated external to the comparator circuit. One skilled in the art will recognize that the LED may be alternatively replaced with any indicator device, such as a simple light bulb, or a readout on a liquid crystal display or other alphanumeric display mechanism.

Alternatively, for a speaker system that includes an internal microprocessor, the resulting PWM signals from each of the speaker analog circuits **290a-290n** under test are presented to the microprocessor **110** (**FIGURE 1**) for interpretation and display. Rather than an LED, the status indicators **206** may be displayed to the operator through any display mechanism available to the speaker system **145** such as a computer display monitor, LED circuit, LED array circuit, or LCD.

FIGURE 4 shows the power diagnostics **270** of the present invention. As is shown in **FIGURE 2**, the diagnostics circuit **295** of the present invention achieves full analog diagnostic capability for the speaker system by providing power diagnostics **270** in addition to the analog diagnostics **275** described above. **FIGURE 4** shows that the power diagnostics **270** are integral to the power circuit for speaker system **145,** which is a circuit well known in the art. The AC power from the power input is sent through a rectifier **400** that rectifies the AC signal into a rectified signal **285**. **FIGURE 4** shows that the rectified signal **285** is then sent to an AC power test indicator **250,** which indicates to the user or technician whether AC power is being sufficiently supplied to the speaker system **145**, and to an AC-to-DC conversion circuit **410** that generates multiple DC voltages **5V**, **12V**, **24V**. While **FIGURE 4** shows that the AC-to-DC conversion circuit **410** generates three DC voltages constituting five (5), twelve (12) and twenty-four (24) volts, the AC-to-DC conversion circuit **410** may generate any number of signals having any voltage value known in the art. These DC voltages **5V**, **12V**, **24V** are each routed to a separate DC power test indicator **450a**, **450b**, **450c**, respectively. In this manner the power diagnostics **270** further test power at the output of the AC-to-DC conversion circuit **410** of the power supply design. This provides the analog diagnostic information concerning whether or not DC power is being sufficiently supplied to the circuits on the PCB. The AC power test indicator **250** and DC power test indicators **450a, 450b, 450c** are LED circuits in the preferred embodiment.

Those skilled in the art will recognize that, based upon the teachings herein, several modifications may be made to the embodiments described above. For example, all power test indicators **250a-250d** could be placed in one central location

rather than being placed on individual speakers. Similarly, the LED circuits comprising the analog test indicators **260a-260n** and the AC-to-DC test indicators **450a-450c** could also be placed in the central location. Each of the indicators **250a-250d, 260a-260n, 450a-450c** may be, instead of an LED, any indicator device, such as a simple light bulb, a liquid crystal display, or any alphanumeric display mechanism.

While particular embodiments of the present invention have been shown and described, it will be recognized to those skilled in the art that, based upon the teachings herein, further changes and modifications may be made without departing from this invention and its broader aspects, and thus, the appended claims are to encompass within their scope all such changes and modifications as are within the true spirit and scope of this invention.

WHAT IS CLAIMED IS:

1. A speaker system, comprising :

at least one transducer;

at least one speaker analog circuit; and

a diagnostics circuit coupled to the at least one transducer and the at least one speaker analog circuit.

2. The speaker system recited in Claim 1, wherein the diagnostics circuit further comprises a power diagnostics circuit.

3. The speaker system recited in Claim 2, wherein the power diagnostics circuit further comprises:

a rectifier; and

at least one AC power test indicator coupled to the rectifier.

4. The speaker system recited in Claim 2, wherein the power diagnostics circuit further comprises:

an AC-to-DC conversion circuit; and

at least one DC power test indicator coupled to the AC-to-DC conversion circuit.

5. The speaker system recited in Claim 1, wherein the diagnostics circuit further comprises an analog diagnostics circuit.

6. The speaker system recited in Claim 5, wherein the analog diagnostics circuit further comprises:

a diagnostic mode activation mechanism; and

a diagnostic signal generation circuit coupled to the diagnostic mode activation mechanism and coupled to the at least one speaker analog circuit.

7. The speaker system recited in Claim 6, wherein the analog diagnostics circuit further comprises;

an analog activity sensor that is coupled to the output of each speaker analog circuit and that generates a corresponding status indicator for each speaker analog circuit; and

at least one analog test indicator, wherein each of the at least one analog test indicator is coupled to the analog activity sensor, each analog test indicator receiving at least one of the status indicators.

8. The speaker system recited in Claim 7, wherein the analog activity sensor further comprises at least one transistor.

9. A speaker system recited in Claim 7, wherein the analog activity sensor further comprises at least one comparator.

10. A speaker system recited in Claim 6, wherein each at least one transducer is coupled to the diagnostic signal generation circuit.

11. A speaker system recited in Claim 10, wherein:

the diagnostic signal generation circuit generates at least one test signal;

each speaker analog circuit receives at least one of the at least one test signal; and

each transducer receives at least one of the at least one test signal.

12. A computer system comprising:

a processor;

a memory coupled to the processor; and

a speaker system coupled to the processor, wherein the speaker system includes a diagnostics circuit.

13. The computer system recited in Claim 12, wherein the speaker system further comprises:

at least one transducer; and

at least one speaker analog circuit, wherein the diagnostics circuit is coupled to the at least one transducer and the at least one speaker analog circuit.

14. The computer system recited in Claim 12, wherein the diagnostics circuit further comprises a power diagnostics circuit.

15. The computer system recited in Claim 14, wherein the power diagnostics circuit further comprises:

a rectifier; and

at least one AC power test indicator coupled to the rectifier.

16. The computer system recited in Claim 14, wherein the power diagnostics circuit further comprises:

an AC-to-DC conversion circuit; and

at least one DC power test indicator coupled to the AC-to-DC conversion circuit.

17. The computer system recited in Claim 12, wherein the diagnostics circuit further comprises an analog diagnostics circuit.

18. The computer system recited in Claim 17, wherein the analog diagnostics circuit further comprises:

a diagnostic mode activation mechanism; and

a diagnostic signal generation circuit coupled to the diagnostic mode activation mechanism and coupled to the at least one speaker analog circuit.

19. The computer system recited in Claim 18, wherein the analog diagnostics circuit further comprises:

an analog activity sensor that is coupled to the output of each speaker analog circuit and that generates a corresponding status indicator for each speaker analog circuit; and

at least one analog test indicator, wherein each of the at least one analog test indicator is coupled to the analog activity sensor, each analog test indicator receiving at least one of the status indicators.

20. The computer system recited in Claim 19, wherein the analog activity sensor further comprises at least one transistor.

21. The computer system recited in Claim 19, wherein the analog activity sensor further comprises at least one comparator.

22. The computer system recited in Claim 18, wherein each at least one transducer is coupled to the diagnostic signal generation circuit.

23. The computer system recited in Claim 22, wherein:

the diagnostic signal generation circuit generates at least one test signal;

each speaker analog circuit receives at least one of the at least one test signal; and

each transducer receives at least one of the at least one test signal.

INTEGRATED SELF DIAGNOSTICS FOR LOUDSPEAKER SYSTEMS

David Konetski
Joe Curley

ABSTRACT OF THE DISCLOSURE

The present invention relates to a self-diagnostic circuit for speaker systems that allows a speaker system to generate its own test signals, e.g., tones, appropriate for the transducer(s) in the speaker system. The test signals are routed to the analog circuits in the speaker system. The test signals are also routed to the transducers, so that an operator can evaluate speaker output tones. In one embodiment, the test signals are also routed to an analog activity sensor that senses activity in the speaker analog circuit paths and sends a status indicator to be displayed to the operator. In a first embodiment, the self-diagnostic circuit is part of a stand-alone speaker system, such as a home theater sound system. In a second embodiment, the self-diagnostic circuit is included in a speaker system that is included in a computer system.

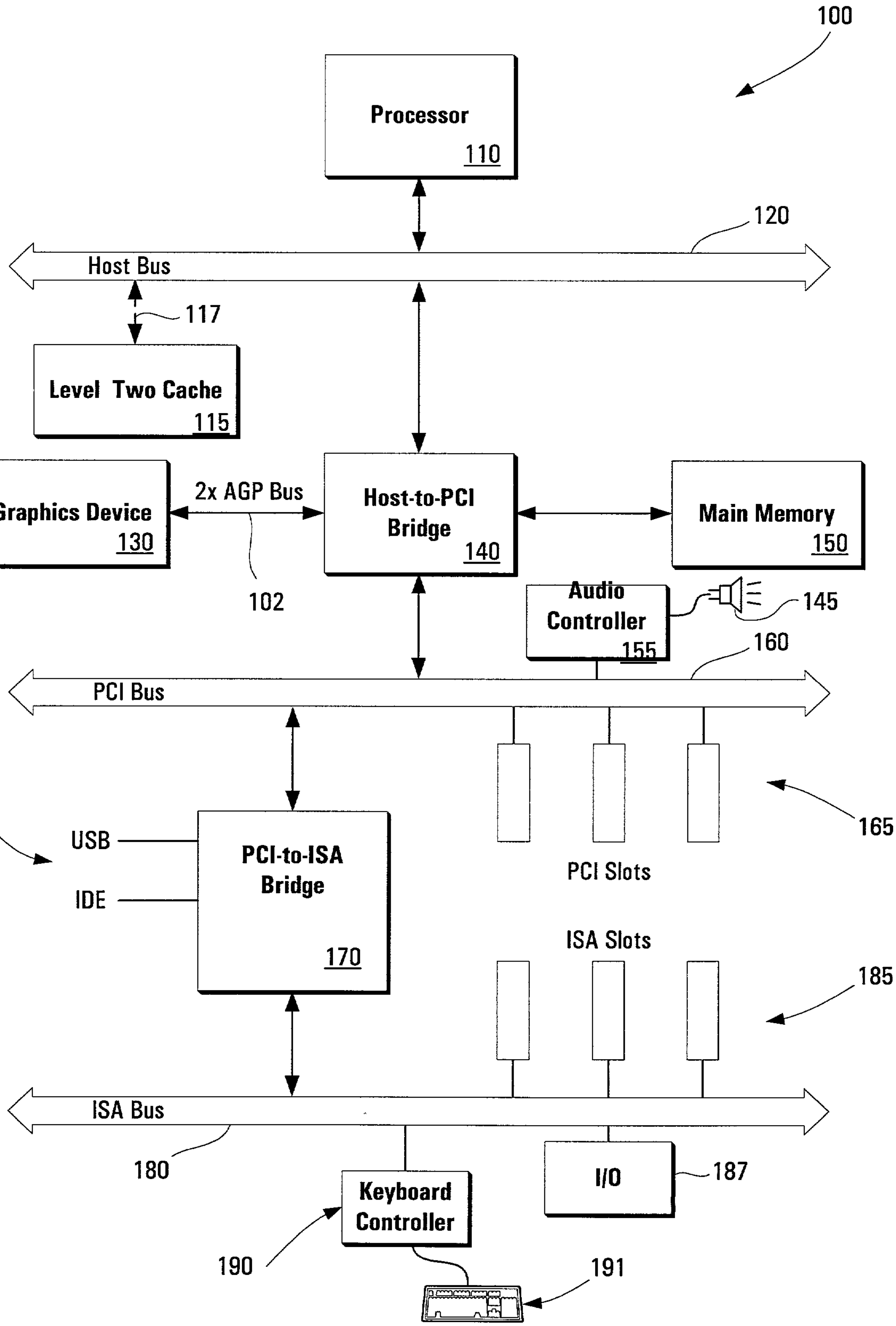
100
Processor
110
120
Host Bus
117
Level Two Cache
115
Graphics Device
130
2x AGP Bus
Host-to-PCI
Bridge
140
Main Memory
150
102
Audio
Controller
155
145
160
PCI Bus
175
USB
IDE
PCI-to-ISA
Bridge
170
PCI Slots
165
ISA Slots
185
ISA Bus
180
Keyboard
Controller
I/O
187
190
191

FIG. 1

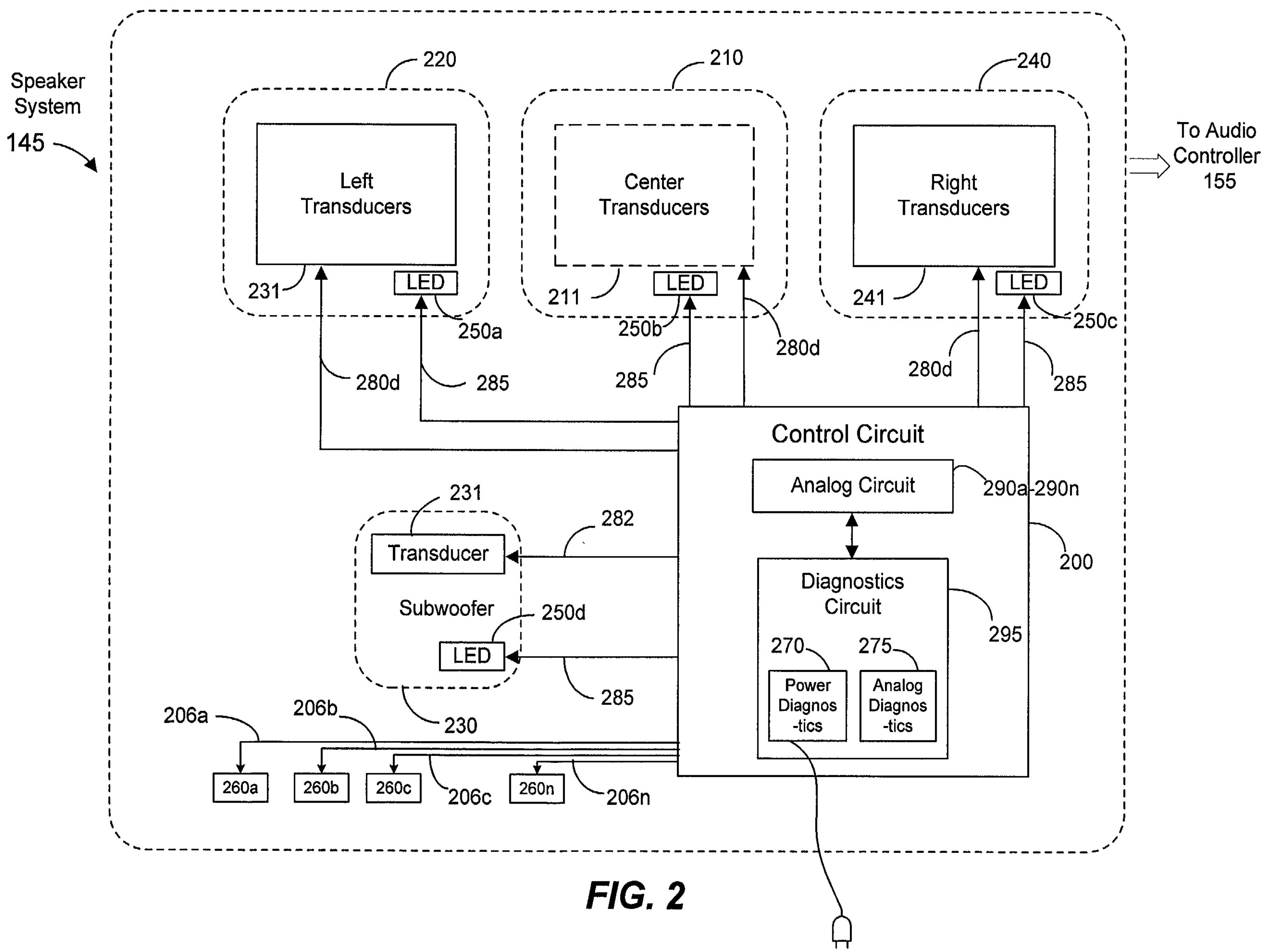
Speaker
System
145
220
210
240
Left
Transducers
Center
Transducers
Right
Transducers
To Audio
Controller
155
231
LED
211
LED
241
LED
250a
250b
250c
280d
285
285
280d
280d
285
Control Circuit
Analog Circuit
290a-290n
231
Transducer
282
200
Subwoofer
250d
LED
Diagnostics
Circuit
295
270
275
Power
Diagnos
-tics
Analog
Diagnos
-tics
285
230
206a
206b
260a
260b
260c
206c
260n
206n

FIG. 2

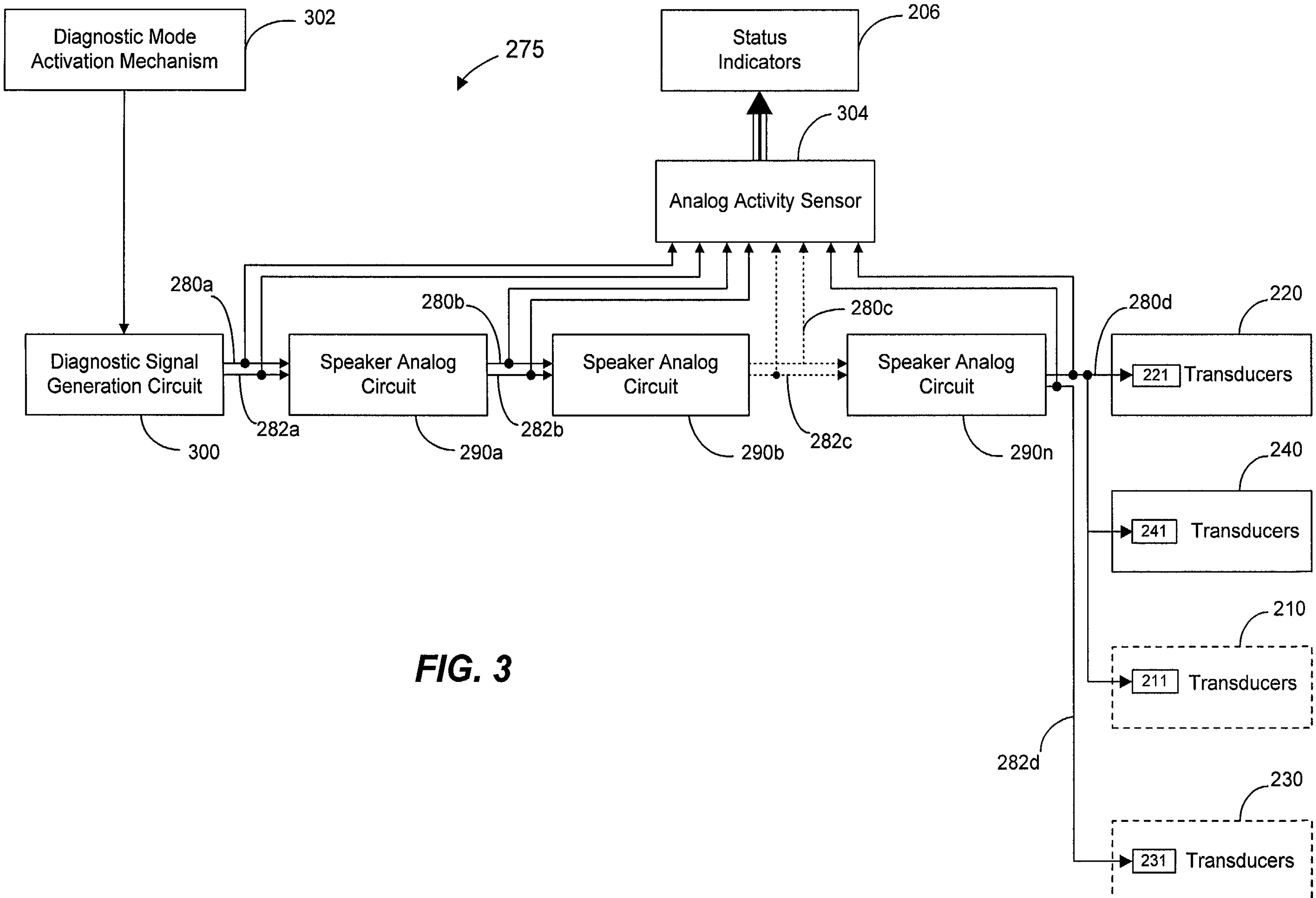
Diagnostic Mode Activation Mechanism
302
275
Status Indicators
206
304
Analog Activity Sensor
280a
280b
280c
280d
220
Diagnostic Signal Generation Circuit
Speaker Analog Circuit
Speaker Analog Circuit
Speaker Analog Circuit
221
Transducers
282a
282b
282c
300
290a
290b
290n
240
241
Transducers
210
211
Transducers
282d
230
231
Transducers

FIG. 3

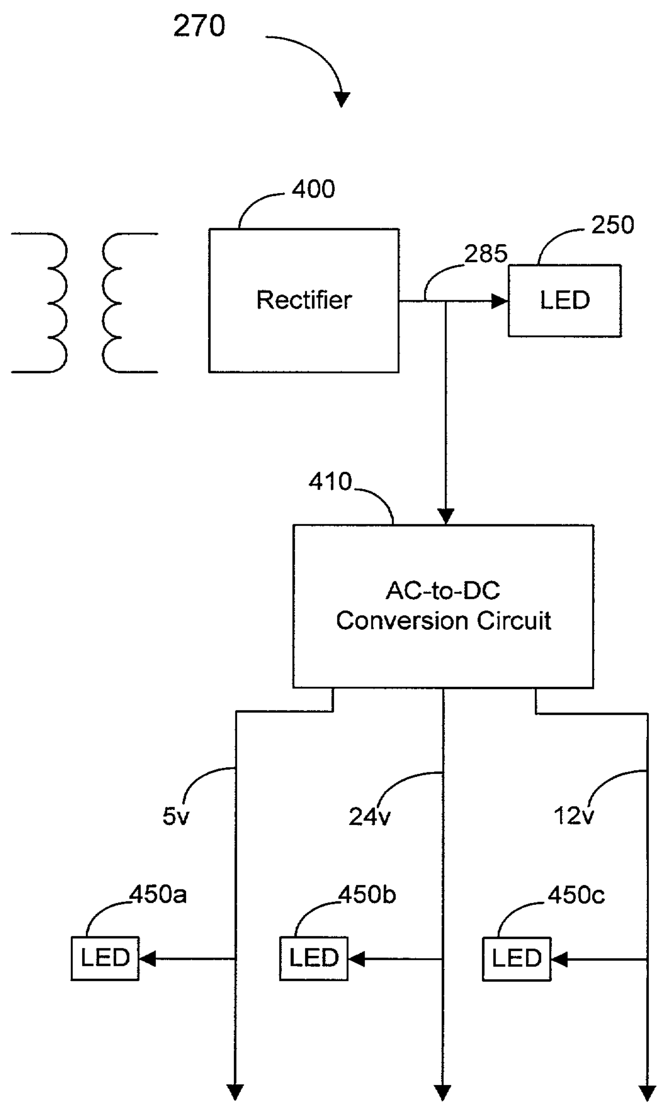
270
400
Rectifier
285
250
LED
410
AC-to-DC
Conversion Circuit
5v
24v
12v
450a
LED
450b
LED
450c
LED

FIG. 4

DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below adjacent to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of subject matter (process, machine, manufacture, or composition of matter, or an improvement thereof) which is claimed and for which a patent is sought by way of the application entitled

Integrated Self Diagnostics For Loudspeaker Systems

which (check) ☒ is attached hereto.
☐ and is amended by the Preliminary Amendment attached hereto.
☐ was filed on ______________ as Application Serial No. ________________
☐ and was amended on ___ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information, which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, § 119(a)-(d) of any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

Prior Foreign Application(s)			Priority Claimed	
Number	Country	Day/Month/Year Filed	Yes	No
N/A			☐	☐

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below:

Provisional Application Number	Filing Date
N/A	

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) or PCT international application(s) designating the United States of America listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information, which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56, which became available between the filing date of the prior application(s) and the national or PCT international filing date of this application:

Application Serial No.	Filing Date	Status (patented, pending, abandoned)
N/A		

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the United States Patent and Trademark Office connected therewith:

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